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COMMENTARY

The Innovation Nutrition

From systemic stratifying to individual tailoring: An innovative framework for precision nutrition in inflammatory bowel disease

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Amid rising global burden of inflammatory bowel disease (IBD), the dietary determinants of disease onset and progression have become sharp research and clinical focus. In a recent *Nature Reviews Gastroenterology & Hepatology*, "Precision nutrition for the prevention and management of inflammatory bowel disease" by Chen et al. interrogates this critical diet-IBD nexus.[1] The review highlights how industrialization and shifting diets complicate IBD prevention, summarizes evidence on diet-driven pathogenesis, and explores sources of heterogeneous dietary responses. It integrates multi-omics, AI, and real-time monitoring to move beyond one-size-fits-all advice toward personalized interventions using demographic, phenotypic, microbial, and environmental data. This commentary appraises the framework's evidentiary basis, operational clarity, and translational feasibility, with emphasis on China-specific opportunities and barriers (Figure 1).

THE IMPORTANCE OF PRECISION NUTRITION IN IBD

As a chronic, relapsing inflammatory gastrointestinal disorder, IBD is highly amenable to dietary modulation. Higher intakes of antioxidant nutrients, vitamin D, dietary fiber, fruits, and vegetables, and adherence to a Mediterranean diet are consistently associated with reduced IBD risk and improved long-term prognostic outcomes. Conversely, excessive consumption of ultra-processed foods, red meat, high-fat and high-protein animal-sourced diets, and sugar-sweetened beverages increases disease susceptibility. Appropriate dietary regimens with consensus are strongly urged. Precision nutrition tailors prescriptions to individual profiles, including age, ethnicity, disease activity, genetics, and microbiota, to mitigate heterogeneous responses.

However, much of the evidence comes from observational studies and retrospective analyses. Prospective randomized trials directly testing causal dietary effects on IBD outcomes remain scarce. Heterogeneity in dietary assessment methods, confounding factors, and population studies weaken causal certainty. Clinicians must recognize that current dietary recommendations are largely based on low-quality evidence, underscoring the need for further interventional studies to provide robust validation.

THREE-TIER FRAMEWORK OF PRECISION NUTRITION

The review innovatively proposes a three-tier implementation framework to advance stratified and personalized IBD nutritional management.[1] Although the tiered structure serves as a practical guide for structuring complex information, criteria for tier advancement and evidentiary thresholds per tier remain unspecified.

Phenotype-based precision nutrition

This approach stratifies individuals based on clinical and demographic characteristics, such as life stage, ethnicity, and disease activity. It is suitable for routine practice, refining general recommendations into subgroup-specific strategies. For instance, it can guide decisions like recommending the Mediterranean diet for adults in remission. But no clinical trial has demonstrated superiority of phenotype-based stratification over standard guideline-recommended regimens.

Omics-based precision nutrition

This tier identifies biomarkers that distinguish responders from non-responders via genomic, metagenomic and metabolomic profiling. By pharmacogenetic screening of certain genes (such as aldehyde dehydrogenase, ALDH), one can find individual patients with IBD who possess ability to tolerate harmful diet including alcohol as demonstrated in a recent work[2]. Nevertheless, this strategy faces notable challenges, including low reproducibility across independent cohorts, substantial costs, and an incomplete understanding of underlying biological mechanisms.

Integrated precision nutrition

This tier synthesizes data from multi-omics, dynamic phenotyping, wearables, and AI to enable continuous optimization. However, tools like "digital gut twin" remain aspirational. Validation, cost-effectiveness, and ethical safeguards are needed before clinical deployment.

Pediatric considerations deserve dedicated attention. Nutritional management is especially critical in pediatric IBD because of its impact on growth, pubertal development, and long-term disease burden. Exclusive enteral nutrition (EEN) remains a first-line induction therapy for pediatric Crohn's disease, yet mechanisms are incompletely understood. The three-tier framework should incorporate age-specific growth-adjusted nutrient targets, developmentally appropriate adherence strategies, and longitudinal monitoring of growth and pubertal outcomes. Long-term safety data on restrictive diets in children are lacking and warrant investigation.

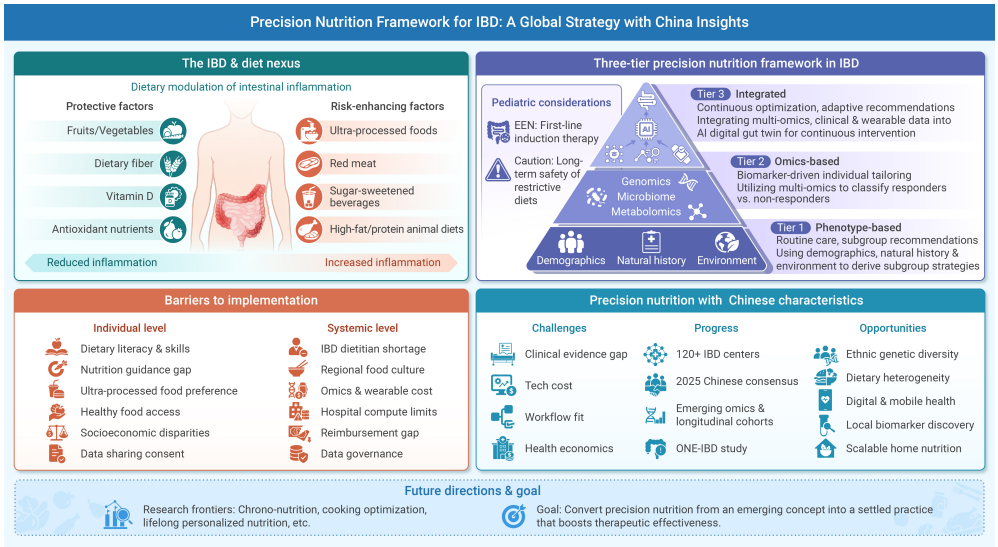

Figure 1. Precision nutrition framework for IBD: A global strategy with China insights.

SUPPORTING ELEMENTS AND BARRIERS OF PRECISION NUTRITION

The review outlines the tech ecosystem for scaling this framework.[1] Modern tools like wearables and smart capsules enable objective monitoring, reducing reporting bias, while

AI integrates data to predict responses and generate personalized plans. Clinically, precision nutrition follows three workflows: setting tiered dynamic goals (short-term symptom/inflammation control and long-term complication prevention/quality-of-life improvement, tailored for special groups), stratifying individuals via a three-tiered framework to validate predictive models, and sustaining interventions through counseling, digital follow-up, and N-of-1 trials to enhance adherence and optimize outcomes.

The review also highlights key real-world barriers hindering widespread clinical adoption.[1] At the individual level, most patients possess limited dietary literacy and cooking skills, lack access to authoritative nutritional information, and prefer ultra-processed foods. At the systemic level, many countries face prominent challenges, including a severe shortage of IBD-specialized dietitians, limited access to healthy dietary options, and structural constraints imposed by regional food cultures and socioeconomic disparities. Beyond these mentioned, additional barriers include the high cost of multi-omics profiling and wearable devices, lack of reimbursement mechanisms, insufficient computational infrastructure in many hospitals, and the absence of standardized data governance frameworks. Algorithmic transparency and potential biases in AI-driven recommendations, especially when training data lack ethnic diversity, raise ethical concerns that must be proactively addressed. Data privacy, consent for genomic and microbiome data sharing, and security of continuous wearable data streams are essential considerations for responsible implementation.

PROGRESS, OPPORTUNITIES, AND CHALLENGES OF PRECISION NUTRITION IN CHINA

In China, IBD nutritional management has witnessed rapid progress in recent years, yet it remains in an early transitional stage, shifting from conventional empirical nutritional support to standardized nutritional therapy and, ultimately, to precision intervention. Substantial improvements are required in standardization, refinement, and individualization of domestic clinical practice. China has established over 120 specialized IBD centers across the country, where accredited dietitians are integral members of the multidisciplinary team (MDT) involved in patient care. The release of the third edition of the Chinese Expert Consensus on Nutritional Therapy for Inflammatory Bowel Disease[3] in 2025 marked a key milestone, which standardizes malnutrition diagnostic criteria, elaborates standardized therapeutic protocols, and formalizes dynamic monitoring workflows. This consensus reinforces the central clinical value of dietary intervention and provides authoritative, nationwide guidance for standardized IBD nutritional management. In addition, a consensus on diet and lifestyle for the long-term management of Chinese patients is currently being developed. Preliminary exploratory research on IBD precision nutrition is also underway in China. Relevant studies have adopted multi-objective programming and collaborative algorithms to construct an optimized dietary recommendation model for adult IBD patients, balancing fundamental nutritional demands, modulation of pro- and anti-inflammatory nutrient homeostasis, and individual dietary preferences. Notably, the ONE-IBD Study by Chen et al, the first Chinese prospective IBD cohort integrating multi-omics profiling, dynamic nutritional monitoring and environmental exposure assessment, is designed to generate high-quality, population-specific original data, laying a solid foundation for localized precision nutrition research and translation.

Despite these advances, domestic IBD nutritional management remains largely exploratory. A substantial proportion of patients lack professional nutritional guidance, leading to unnecessary food avoidance and unbalanced dietary patterns, which further elevate malnutrition risk and exacerbates disease fluctuation. While Western healthcare systems have established stratified and personalized frameworks[4] based on IBD subtype, disease activity and nutritional status, current domestic practices predominantly focus on correcting macronutrient deficiencies, such as inadequate energy and protein intake. Phenotype-based stratified intervention and molecular profile-based personalized nutrition remain under-implemented in routine clinical care. The clinical translation and implementation of precision nutrition for IBD in China are hindered by four major challenges pertaining to clinical evidence, technological affordability, clinical workflow integration, and health economic validation. Like global research, domestic nutritional research lacks high-quality population-specific evidence, attributable to limited dietary assessment precision, methodological constraints, and insufficient causal verification between dietary exposure and disease progression.[5] Advanced multi-omics characterization, big-data stratification and artificial intelligence-assisted predictive modeling require substantial long-term financial support, infrastructure construction and dedicated research workforce input, imposing substantial translational barriers. In routine clinical practice, multidimensional individualized nutritional evaluation protocols cannot be effectively integrated into existing IBD management workflows, while inadequate professional training further impedes standardized implementation. Additionally, the absence of systematic cost-effectiveness analyses fails to support nationwide policy promotion and clinical application.

FUTURE PERSPECTIVES OF PRECISION NUTRITION

The review outlines promising future research directions such as circadian chrononutrition, seasonal dietary adjustments, cooking optimization, and framework balancing efficacy, affordability and sustainability.[1] Progress hinges on expanding multi-omics cohorts, refining monitoring technologies, and optimizing AI to accelerate clinical translation.

For Chinese populations, adopting the three-tiered nutritional framework enables context-specific optimization. Leveraging China's multi-ethnic genetic diversity and regional dietary heterogeneity facilitates the construction of localized phenotype-diet databases and ethnicity-adapted nutritional biomarkers. Integrating domestic mobile healthcare and artificial intelligence techniques can establish intelligent, whole-course home-based nutritional management systems, compensating for workforce shortages and promoting standardized, equitable, and scalable precision nutrition for IBD in real-world clinical settings.

In practice, implementation of the phenotype-omics-integration framework of precision nutrition for IBD in China is recommended step-by-step. A phased, evidence-calibrated approach should be to optimize Tier 1 now, selectively validate Tier 2 in research-capable centers, and defer Tier 3 until prospective data confirm safety, efficacy, and cost-effectiveness. Ethnic dietary diversity and digital healthcare infrastructure are genuine strengths that can accelerate this process, but only if paired with rigorous validation, transparent governance, and realistic expectations about what current evidence can support. The ultimate goal remains the same: to transform precision nutrition from an emerging concept into a standard-of-care modality that improves outcomes of patients with IBD.

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DECLARATION OF INTERESTS

The authors declare no competing interests.